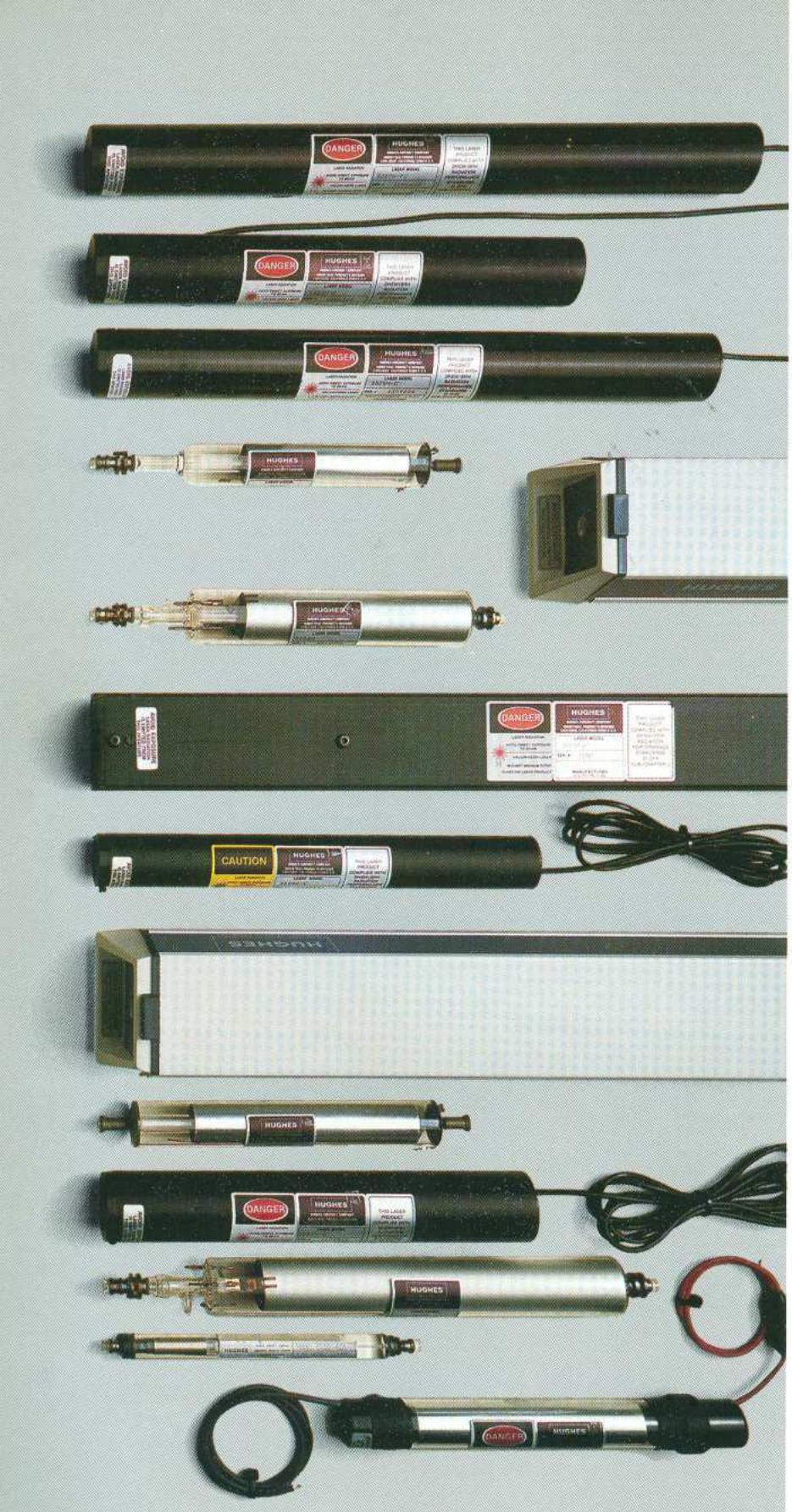
HELIUM-NEON LASERS

HUGHES

HUGHES AIRCRAFT COMPANY

INDUSTRIAL PRODUCTS DIVISION
CARLSBAD, CALIFORNIA



Helium-Neon Lasers

CONTENTS

The first operating laser was developed at Hughes Research Laboratories in 1960 when a ruby crystal was used for amplification of light. Hughes has been a leader in laser technology ever since that scientific breakthrough. Today, Hughes Industrial Products Division in Carlsbad, California, is recognized as a major supplier of two primary types of lasers for commercial and industrial applications: helium-neon lasers and waveguide CO_2 lasers. The following pages detail specifications and operating characteristics for helium-neon lasers. Hughes makes systems and equipment to fulfill a variety of requirements, and provides customer assistance in evaluating proposed applications.

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Specifications are subject to change without notice.

Applications

Helium-neon lasers produce a very intense, narrow beam of coherent red light that maintains a slowly diverging diameter over long distances. The laser beam can be manipulated, controlled and detected quite easily. By expanding or focusing the beam with simple optical elements, the desired spot size can be achieved at almost any distance. Helium-neon laser applications are determined largely by their power output and beam divergence. NCDRH* Class II and Class IIIb helium-neon lasers are typically used for alignment, holographic recording and audio/visual data links, character recognition, non-impact printing, supermarket scanners, construction guidelines and inspection/measuring.

Hughes helium-neon lasers are about the size of an ordinary flashlight, easy to operate, and have a working life of many thousands of hours. Remaining cool in operation and maintenance free, Hughes helium-neon lasers are available in protective metal enclosures. The Hughes Series 3000H Helium-Neon Laser Systems offer a complete range of power options with conveniently packaged laser heads and compatible power supplies.

Quality

Hughes helium-neon lasers feature a proprietary hard-seal construction for environmental protection under adverse conditions and to provide long storage life. Extra ruggedness is achieved through coaxial, internal mirror construction, a patented concept developed by Hughes. This concept, used in conjunction with specially developed hard glass, improves pointing and dimensional stability over plasma tubes that use conventional glass and construction techniques, and maintains laser beam alignment and power stability under severe conditions of mechanical stress and high temperature environments. Innovative cleaning techniques, stringent process controls and advanced chemical processing equipment assure exceptionally long life.

OEM HELIUM-NEON LASERS AND POWER SUPPLIES

In addition to the standard helium-neon lasers, power supplies, and accessories described here, Hughes provides a variety of plasma tubes, laser heads, and modular ac and dc power supplies for original equipment manufacturers. For information about OEM applications, please call or write the nearest Hughes office or distributor listed on the back cover.

National Center for Devices and Radiological Health (NCDRH), formerly Bureau of Radiological Health, requirements are presented on page 10.

Features

COMPACTNESS: Hughes helium-neon lasers are among the most compact available for their respective power ratings.

RAPID WARM-UP: Warm-up is typically to 95% of full specified power within 5 minutes.

AMPLITUDE STABILITY: Amplitude stability adheres to the theoretical limit through the use of a special isotopic gas mixture that minimizes fluctuations associated with mode sweeping.

BEAM STABILITY: Beam and power stability are the result of the optimized optical cavity design and heat transfer techniques used in the plasma tubes and laser heads.

How to Select a Helium-Neon Laser for Your Application

LINEAR AND RANDOM POLARIZATION

Linear polarization is especially important when the beam to be measured is reflected from a surface or passes through an optical system. *Randomly* polarized beams produce fluctuations in output power when reflected from surfaces that have polarization-sensitive reflection or transmission characteristics. Linear polarization also permits control of the output intensity with a polarizer and permits use of a variety of modulators. If the intended use does not include beam polarization-sensitive optical components, a cost savings may be realized by selecting a randomly polarized laser.

POWER OUTPUT

The output power requirement is determined by two factors: ultimate signal-to-noise ratio and power density incident upon the detector or recording media — factors which may best be determined by experimentation in the user's particular application.

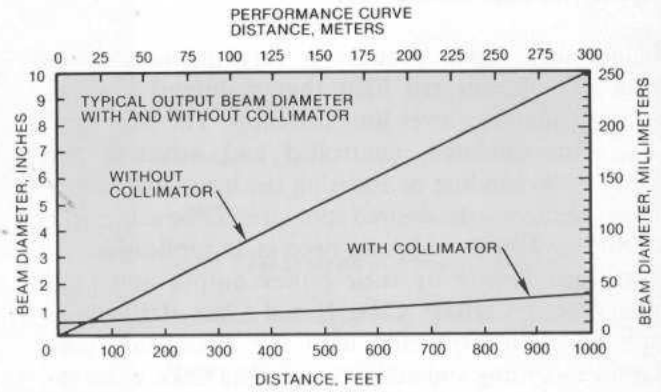
BEAM DIAMETER

Laser beams start with a "waist" at the outer face of the output mirror and gradually diverge over distance. The larger the beam diameter at the waist, the slower the

divergence. The following formula may be used to calculate the beam diameter, d(cm), at a distance, D(cm), given the output beam diameter, d_O(cm), as it leaves the laser.

$$d = d_o \left[1 + 6.492 \times 10^{-9} \frac{D^2}{d_o^4} \right]^{1/2}$$

To minimize beam diameter over long distances, the Hughes Model 3970H Collimator may be used to expand the beam ten times at the waist. As may be seen in the chart below, the beam diameter from the 3970H is smaller than from a laser without a collimator at distances beyond approximately 60 feet (18 meters).



Hughes Series 3000 Helium-Neon Laser Systems

Hughes Series 3000H Helium-Neon Laser Systems consist of selected laser heads with matched, regulated power supplies. The laser heads are primarily from the Hughes packaged LF Series, with six foot coaxial cables, HV connectors and ¼ turn mechanical beam shutters. The power supplies incorporate total fault protection circuitry and feature feedback regulated start voltage. For complete specifications on power supplies, see Series 4030/5000 Power Supplies on page 6.

System Specifications

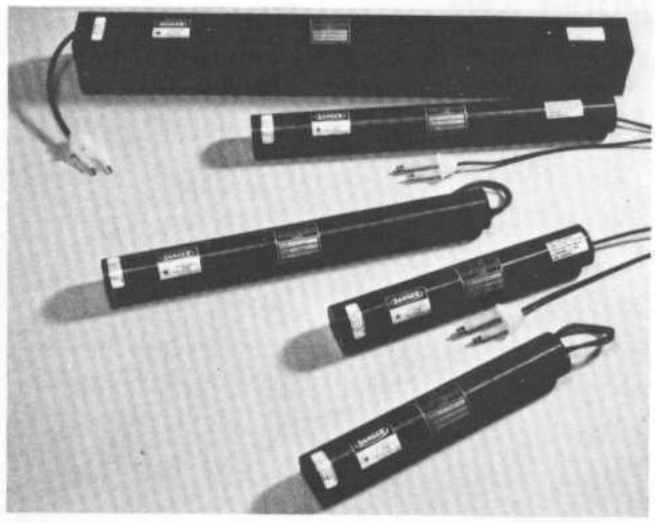
System Number	Laser Head Model Number	Minimum Output Power	Polarization	Power Supply Model Number
3009H	3209H-C*	0.5 mW	Random	5000 4.5 mA
3009H-P	3209H-PC*	0.5 mW	Linear	5000 4.5 mA
3021H	3221H-C	1.0 mW	Random	5020 6.5 mA
3021H-P	3221H-PC	1.0 mW	Linear	5020 6.5 mA
3022H	3222H-C	2.0 mW	Random	5020 6.5 mA
3022H-P	3222H-PC	2.0 mW	Linear	5020 6.5 mA
3023H	3223H-C	3.0 mW	Random	5010 6.5 mA
3023H-P	3223H-PC	3.0 mW	Linear	5010 6.5 mA
3024H	3224H-C	4.0 mW	Random	5020 6.5 mA
3024H-P	3224H-PC	4.0 mW	Linear	5020 6.5 mA
3025H	3225H-C	5.0 mW	Random	5020 6.5 mA
3025H-P	3225H-PC	5.0 mW	Linear	5020 6.5 mA
3027H	3227H-C	7.5 mW	Random	5040 7.0 mA
3027H-P	3227H-PC	7.5 mW	Linear	5040 7.0 mA
3035H	3235H-C	10.0 mW	Random	4030 9.3 mA
3035H-P	3235H-PC	10.0 mW	Linear	4030 9.3 mA

Note: When ordering Series 3000H Laser Systems, order by System Number. For 230 volt operation add "F" to System Number, for example 3009H-F.

*LC Series Laser Head — NCDRH Class II

LF Series Packaged Laser Heads

Hughes packaged laser heads consist of hardseal plasma tubes, shock mounted in metal enclosures, together with ballast resistors and high voltage connectors. The laser output beam is precisely aligned with the package exterior. This feature allows precision mounting and permits ease of replacement with minor adjustment to the mounting hardware. To satisfy NCDRH safety requirements, all packaged laser heads have a ¼ turn mechanical beam shutter.



Packaged Laser Head Specifications

Model Number	3209H-C* 3209H-PC	3221H-C 3221H-PC	3222H-C 3222H-PC	3223H-C 3223H-PC	3224H-C 3224H-PC	3225H-C 3225H-PC	3227H-C 3227H-PC	3235H-C 3235H-PC
Minimum CW Output Power TEM_{00}, at 632.8 nm (mW)	0.3	1.0	2.0	3.0	4.0	5.0	7.5	10.0
Starting Voltage (kVdc)	8.0	10.0	10.0	10.0	10.0	10.0	10.0	12.0
Beam Diameter $1/e^2$ (mm)	0.49	0.64	0.64	1.37	0.83	0.83	0.80	1.43
Beam Divergence (mrad)	1.7	1.3	1.3	0.7	1.0	1.0	1.1	0.6
Longitudinal Mode Spacing (c/2L) (MHz)	635	685	685	500	430	430	400	265
Amplitude Noise, rms (30 Hz – 10 MHz)	1%	1%	1%	1%	1%	1%	1%	1.5%
Angular Drift (mrad) from cold start	<0.20	<0.20	<0.20	<0.25	<0.30	<0.30	<0.40	—
Angular Drift (mrad) after warm-up	<0.03	<0.03	<0.03	<0.035	<0.04	<0.04	<0.06	—
Mass (lb/kg)	0.6/0.3	0.5/0.2	0.5/0.2	0.6/0.3	1.1/0.5	1.1/0.5	1.25/0.6	3.7/1.7
Operating Voltage (Vdc ±100)	1650	1730	1730	1650	2350	2350	2700	3400
Operating Current (mA ±0.1)	4.5	6.5	6.5	7.0	6.5	6.5	7.0	9.3

* LC Series Laser Head — NCDRH Class II
P Denotes Units having Linear Polarization (500:1 MIN)

COMMON SPECIFICATIONS — Models 3209-3227

- Static Alignment — Centered to outer cylinder to <.010 in. Parallel to outer cylinder to <1 mrad.
- Long Term Drift — ±5% in any 8-hour period.

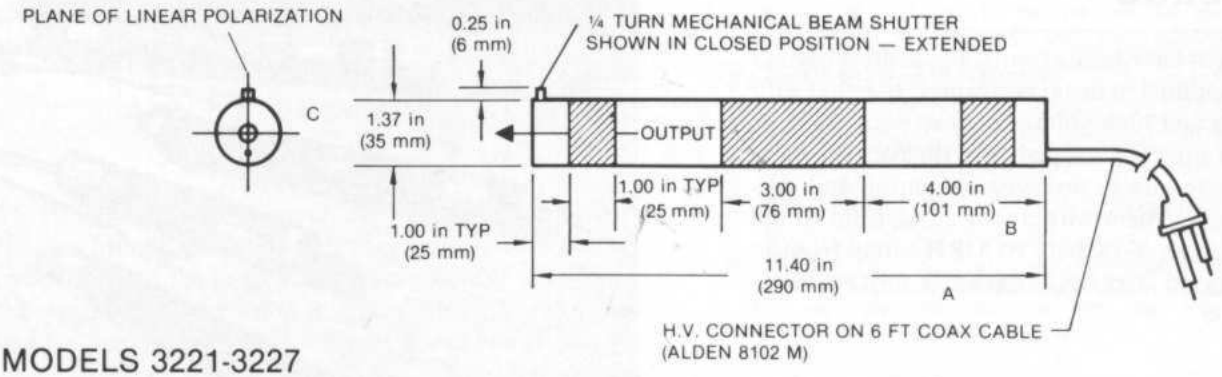
OPERATING SPECIFICATIONS

Temperature	−20° to 50°C
Altitude	Sea level to 10,000 ft
Relative Humidity	0 to 100% (without condensation)

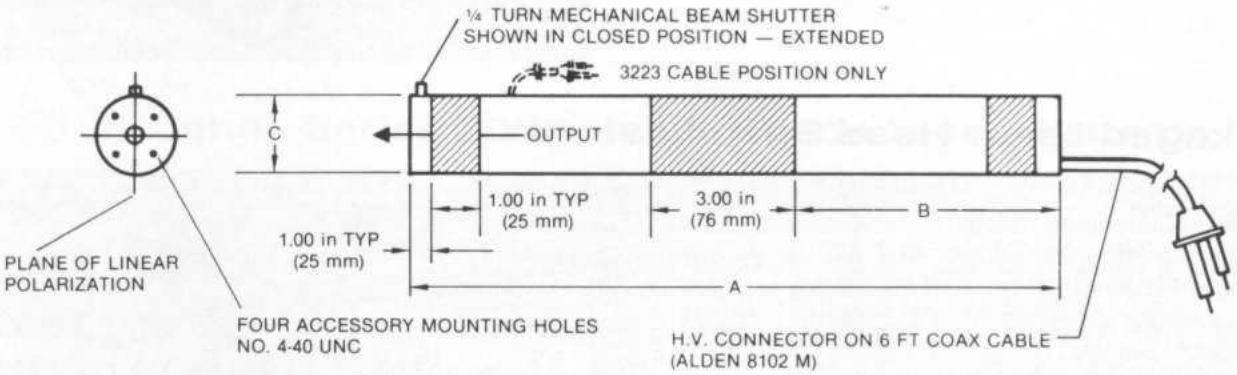
NON-OPERATING SPECIFICATIONS

Temperature	−40° to 80°C
Altitude	Sea level to 70,000 ft
Relative Humidity	0 to 100%
Shock	15 g for 11 ms, 50 g for 1 ms

MODEL 3209



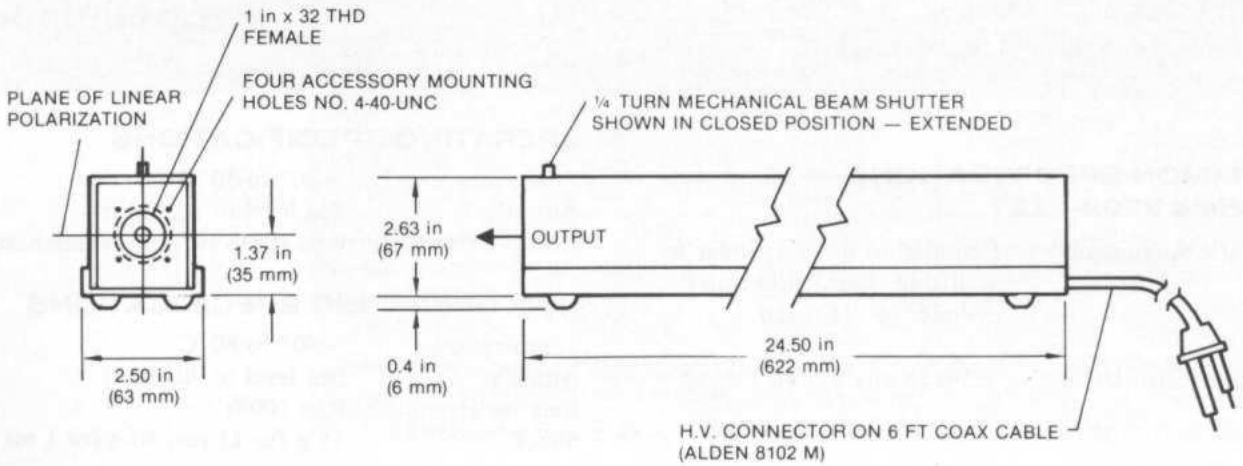
MODELS 3221-3227



RECOMMENDED MOUNTING POSITIONS

DIMEN-SION	3221H-C 3222H-C 3221H-PC 3222H-PC	3223H-C 3223H-PC	3224H-C 3225H-C 3224H-PC 3225H-PC	3227H-C 3227H-PC
A	10.71 in (272 mm)	12.60 in (320 mm)	15.79 in (401 mm)	17.22 in (437 mm)
B	3.75 in (95 mm)	4.80 in (122 mm)	6.30 in (160 mm)	7.11 in (180 mm)
C	1.74 in (44 mm)	1.74 in (44 mm)	1.74 in (44 mm)	1.74 in (44 mm)

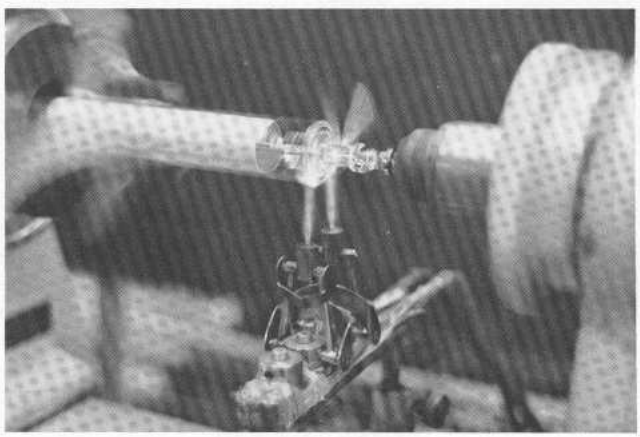
MODEL 3235

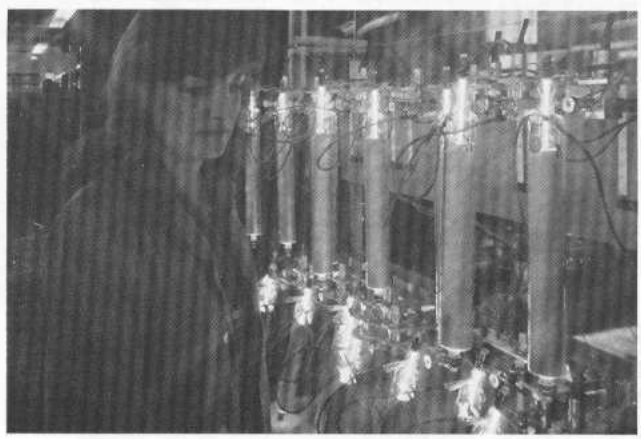


Hughes Hardseal Construction

Hughes hardseal construction utilizes solder glass, controlled surface interfaces and selected materials to create a structural vacuum seal of the laser mirror and discharge chamber. This seal completely eliminates problems that high heat and humidity environments cause in epoxy-sealed laser tubes.

Since hardseal construction can withstand higher temperatures than epoxy, plasma tube processing temperatures are increased to more effectively remove internal residue contamination. This, plus the elimination of water vapor permeation, eliminates the necessity of periodically operating lasers in storage in order to clean out the contaminants that would otherwise build up. Longer life, high reliability and reduced degradation in power output over operating life are among the advantages of hardseal construction.



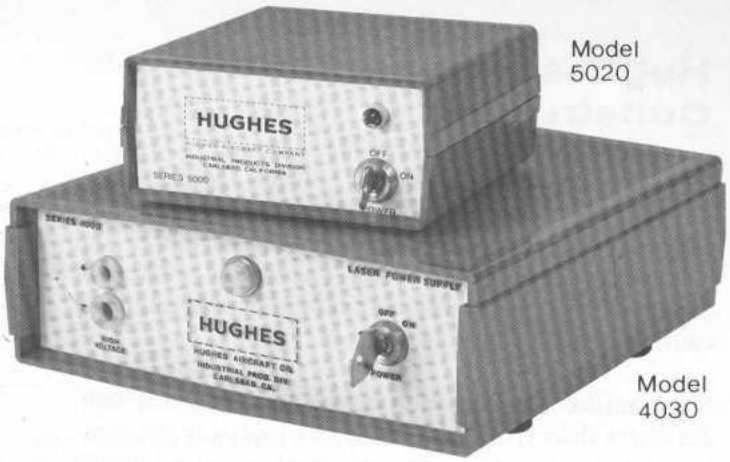


Life Testing

In Hughes two-phase life test program, sample lasers randomly drawn from production lots are placed on test for a minimum of 500 hours. Parameters monitored include noise, beam quality, power output, dropout current and operating voltage. For full-life testing, sample units are run until wear-out or failure occurs. Hughes lasers are preferred by customers worldwide for their long life. Lifetimes in excess of 25,000 hours are typical of many models.

Power Supplies — AC Packaged

The Series 4030/5000 Power Supplies are specially designed to provide the optimum electrical interface with Hughes laser heads. The design provides a time delay ignition (approximately 3 seconds after key switch activation) for application of start-up power. Feedback regulation reduces the power required as the laser "warms up." All models are packaged in standard bench top enclosures to meet NCDRH requirements including key-lock switch, time delay, remote control connector, emission indicator light, six foot ac power cord, and molded high voltage receptacle for output connection to the laser.



Features:

- Key activated switch limits unauthorized operation.
- Pilot light emission indicator gives visual indication that the power supply is in operation.
- Remote control connector remotely controls operation and provides for an external interlock.

Specifications

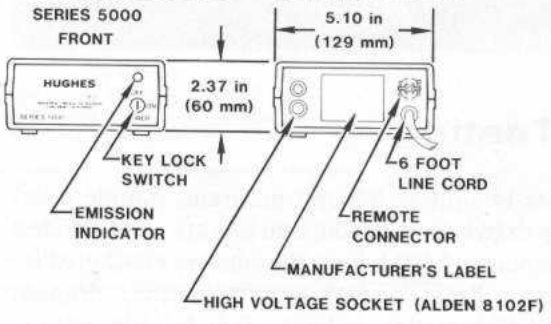
Power Supply Model No.	4030	5000	5020			5040
For Operation with Laser Model	3235H-C 3235H-PC	3209H-C 3209H-PC	3221H-C 3221H-PC 3222H-C 3222H-PC	3223H-C 3223H-PC 3224H-C 3224H-PC	3225H-C 3225H-PC	3227H-C 3227H-PC
Output Start Voltage (Feedback Regulated)	12kV	8kV	10kV			10kV
Output Sustaining Voltage (Vdc) ±100	3400	1650	1730-2450			2700
Output current (mA) ±0.05	9.3	4.5	6.5			7.0
H × W × L	3.0 × 8.5 × 9.0 in (76 × 216 × 229 mm)		2.4 × 5.1 × 5.3 in (61 × 130 × 135mm)			

COMMON SPECIFICATIONS — MODEL 4030/SERIES 5000

• Time Delay Ignition	3-5 seconds
• Mass (4030)	3.4 lb/1.6 kg
(5000)	2.25 lb/1.1 kg
• Frequency	50-400 Hz
• Input Voltage Options	115 Vac ±10% or 230 Vac ±15%

To order models wired for 230 Vac operation, add Letter "F"

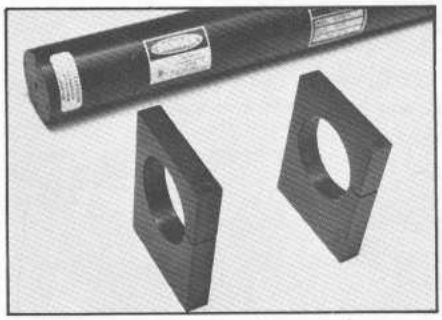
DIMENSIONS — SERIES 5000



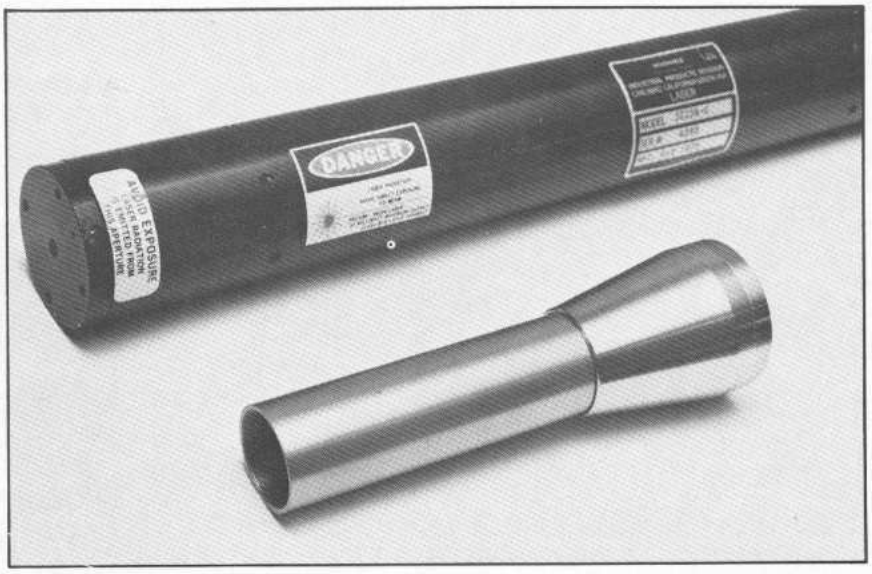
Helium-Neon Laser Warranty

Hughes Industrial Products division warrants all Hughes helium-neon laser systems and all Hughes packaged helium-neon laser heads used with a Hughes power supply to be free from defects in material and workmanship for a period of twelve months from shipment with no hour limit. For full details, ask for our Laser Products Warranty, available upon request.

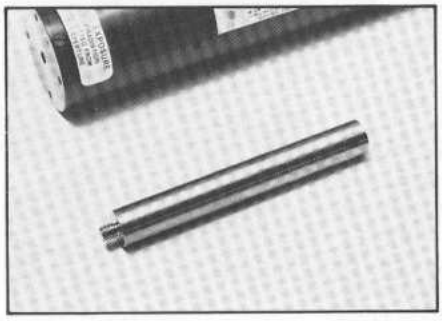
Accessories for LF Series Laser Heads



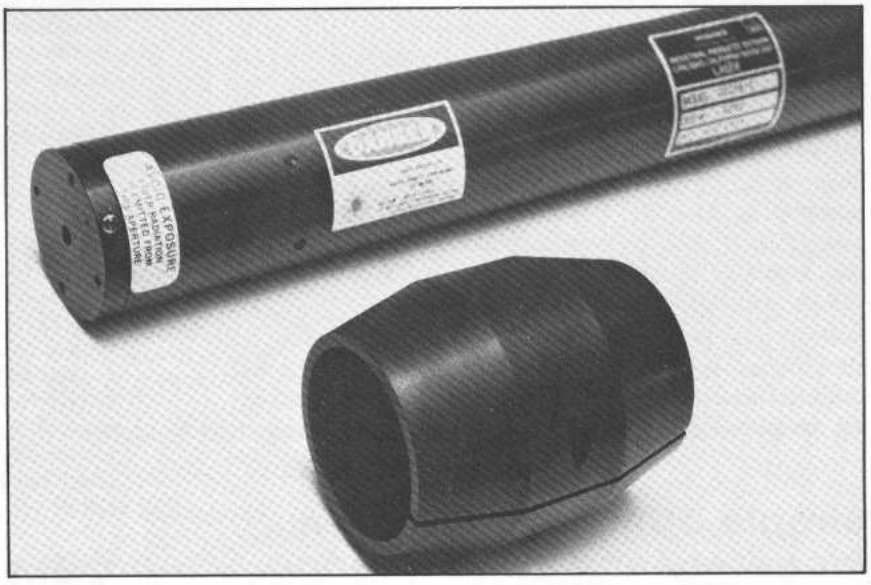
MOUNTING BLOCKS —
MODEL 3972H — enable the packaged laser to be mounted directly to a flat plate or optical rail. A tapped center hole in the blocks permits mounting posts to be used to elevate the laser head from an optical rail or bench.



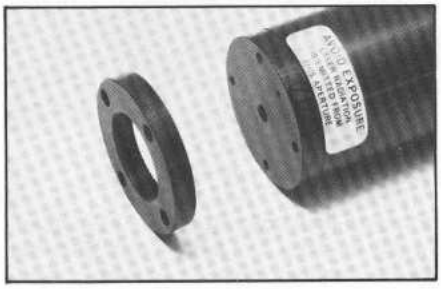
10X COLLIMATOR — MODEL 3970H — expands the laser beam ten times in diameter at the point of exit. This expansion reduces the beam divergence by the magnification factor. (See performance curve on page 2.)



MOUNTING POST —
MODEL 3973H-4 — May be used with the Model 3971H mounting ring or the Model 3972H mounting blocks to elevate the laser head to a desired level. Diameter of the mounting post is 0.5 inch.



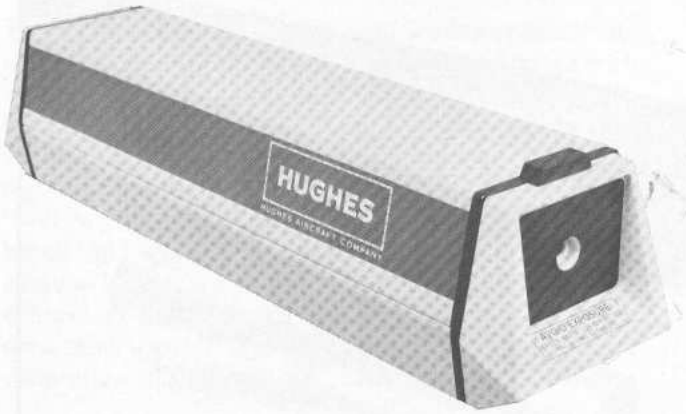
MOUNTING RING — MODEL 3971H — allows the laser heads to be mounted directly to optical rails. The ring mates with mounting post Model 3973H-4.



ADAPTER 1 IN. × 32 T.P.I. —
MODEL 3977H — Bolts directly to laser heads having mechanical beam shutters. It may be used to attach a variety of optical components to the laser.

The Series 3300

Compact, easy-to-use lasers for laboratory, classroom and general use



Hughes lasers with precisely matched power supplies are available in attractive, convenient packages for a broad range of laboratory and general uses.

The Series 3300 covers the 0.4 to 6.0 milliwatt range with choices to provide the user exactly the performance required. In addition, all standard Series 3300 lasers comply with NCDRH requirements.

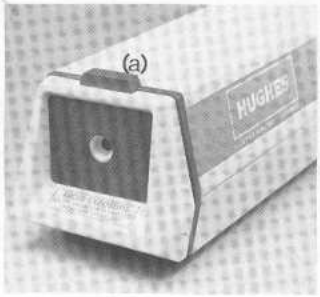
The Model 3309H, NCDRH Class II, systems are ideally suited for use as educational and demonstration tools because they require no special safety precautions. All models include a matched, well-regulated power supply plus controls and safety features necessary for consistent and safe operation.

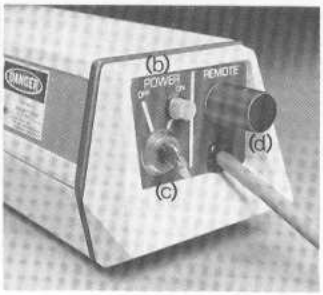
Random and linear polarization are available for each power level. Also, 115 volt ac or the optional 230 volt ac power input may be selected. Several accessories are also available including collimator, accessory adapter, and optical rail mounting plate.

Built-in quality together with controlled life testing on all Hughes lasers and power supplies ensures long, trouble-free use. The good looks and functional packaging are pleasing added features.

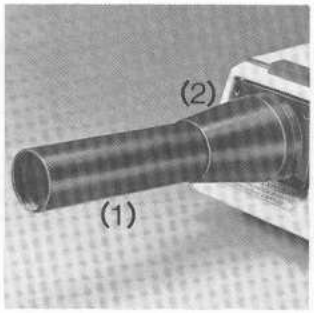
Simple operating features for safety and convenience

- **BEAM ATTENUATOR (a).** Enables user to block the beam without having to disengage the laser, prevents inadvertent eye exposure.
- **INDICATOR LIGHT (b).** Signals that power supply is on and laser is operating.
- **KEY ACTIVATED SWITCH (c).** Discourages unauthorized use of laser. Built-in time delay inhibits laser from lasing for three to five seconds after key switch is turned to "ON" position and indicator light goes on.
- **REMOTE CONTROL CONNECTOR (d).** Allows for remote on/off control via an external switch or safety interlock.

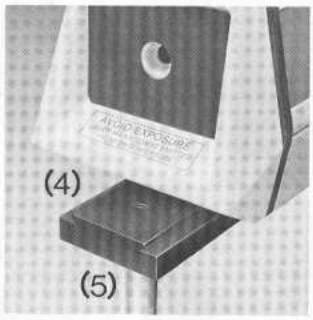




Accessories for the Series 3300



1. **COLLIMATOR** (10×), Model 3970H. Expands laser beam ten times in diameter at point of exit, reducing beam divergence by the magnification factor. Other models available; please consult factory.
2. **ADAPTER BEZEL**, Model 3930H-2. Provides interface for Model 3970H collimator and other optional components.
3. **ADAPTER**, Model 3977H (1 inch × 32 threads per inch). Bolts directly to adapter bezel, is used for attaching a variety of optical components (not shown).
4. **MOUNTING PLATE**, Model 3930H-1. Permits laser to be secured to a mounting base, optical rail or optical bench.
5. **MOUNTING POST**, Model 3973H-4. Provides a convenient and inexpensive means for establishing an optical axis at a given height above an optical rail or bench.



OEM Configuration

The Series 3300 has also been designed with the OEM in mind. An OEM version of each model is available which does not include beam attenuator, keylock switch, indicator light, remote control connector or ac line cord connector and is therefore not NCDRH certified. However, when employed within a system, certification of the system can be supported by reference to the proper Hughes laser head that has been previously certified. Please contact your local representative or the factory for further information about OEM models.

Series 3300 Specifications

MODEL NUMBER (Random) (Polarized)	3309H 3309H-P	3301H 3301H-P	3302H 3302H-P	3304H 3304H-P	3305H 3305H-P	3306H 3306H-P
Laser construction	Hardseal, coaxial, cold cathode					
Output power (mW) [TEM_{00}, 632.8 nm]	0.4	1.0, min	2.0, min	4.0, min	5.0, min	6.0, min
Polarization information ("P" models only) Polarization extinction ratio: Plane of polarization:	500:1 minimum Vertical					
Beam diameter, $1/e^2$ (mm)	0.64*			0.83		
Beam divergence (mrad)	1.3*			1.0		
Longitudinal mode spacing (c/2L) MHz	685			430		
Amplitude noise, rms (30 Hz – 10 MHz)	<1%					
Ripple, 10 Hz to 1 kHz, (p-p)	<0.5%					
Power variation in 8 hrs	< ±2.5%			< ±5.0%		
Power at turn-on (mW)	>.35	>.8	>1.6	>3.2	>4.0	>4.8
Angular drift — From cold start (mrad) After warm-up (mrad)	<0.2 <0.03			<0.3 <0.04		
Maximum warm-up time to full power	15 minutes					
Temperature: Operating Storage	0°C to + 40°C −20°C to + 70°C					
Altitude: Operating Storage	Sea level to 10,000 feet Sea level to 70,000 feet					
Relative humidity: Operating	0 to 100% (without condensation)					
Size (H × W × L)	3.4 × 3.7 × 14.8 in (86 × 94 × 376 mm)			3.4 × 3.7 × 19.1 in (86 × 94 × 485 mm)		
Mass	4.5 lb (2.04 kg)			5.0 lb (2.27 kg)		
Power Supply	Integral with head. All solid state. Feedback regulated output current and start voltage, complete fault protection					
Input voltage (Single Phase)	115 Vac ±10%, 60 Hz (Standard) 230 Vac ±10%, 50-60 Hz* (Specify by ordering "F" version of basic model, i.e. 3309H-PF)					
Power consumption (W)	20					
Time delay from turn-on to light output	1 to 5 seconds					
NCDRH Class	II	IIIb				
NCDRH maximum power (mW)	1.0	5.0		10.0		

*Also available with 0.49 mm beam diameter and 1.7 mrad beam divergence. Specify by ordering "—1" version of the basic model, i.e., 3309H-PF-1. Also available as OEM version. Specify by ordering "M" version of basic model, i.e., 3309H-PFM-1.

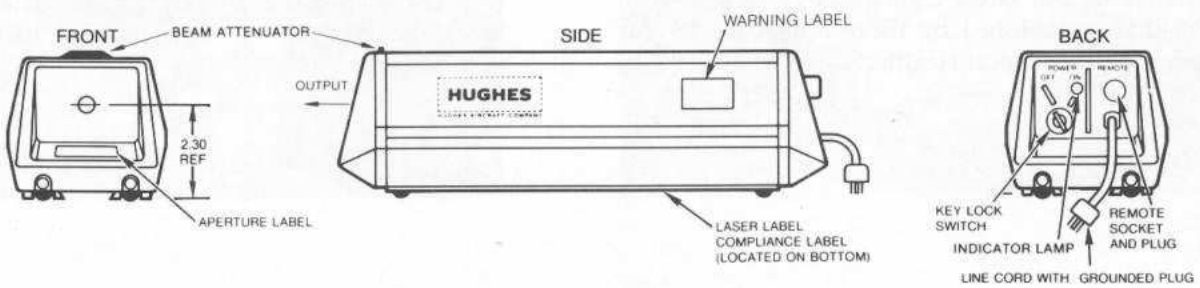
12 DIFFERENT MODELS FROM THE SAME SERIES ADAPT WELL TO ANY APPLICATION

FEATURING:

- High Quality
- NCDRH Certification
- Safe Operation
- Matched Power Supplies
- Available Accessories

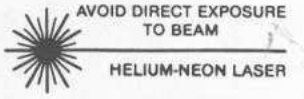
TYPICAL APPLICATIONS:

- Holography
- Data Recording
- Spectroscopy
- Light Scattering
- Velocimetry
- Nondestructive Testing
- Interferometry
- Alignment Systems



CLASS II

LASER RADIATION



MILLIWATT MAXIMUM OUTPUT

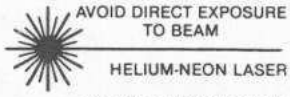
CLASS II LASER PRODUCT

System Model Numbers	Laser Head Model Numbers	Maximum Power Output
3009H	3209H-C	1.0 mW
3009H-P	3209H-PC	1.0 mW
3309H		1.0 mW
3309H-P		1.0 mW

CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

CLASS IIIb

LASER RADIATION



MILLIWATT MAXIMUM OUTPUT

CLASS IIIB LASER PRODUCT

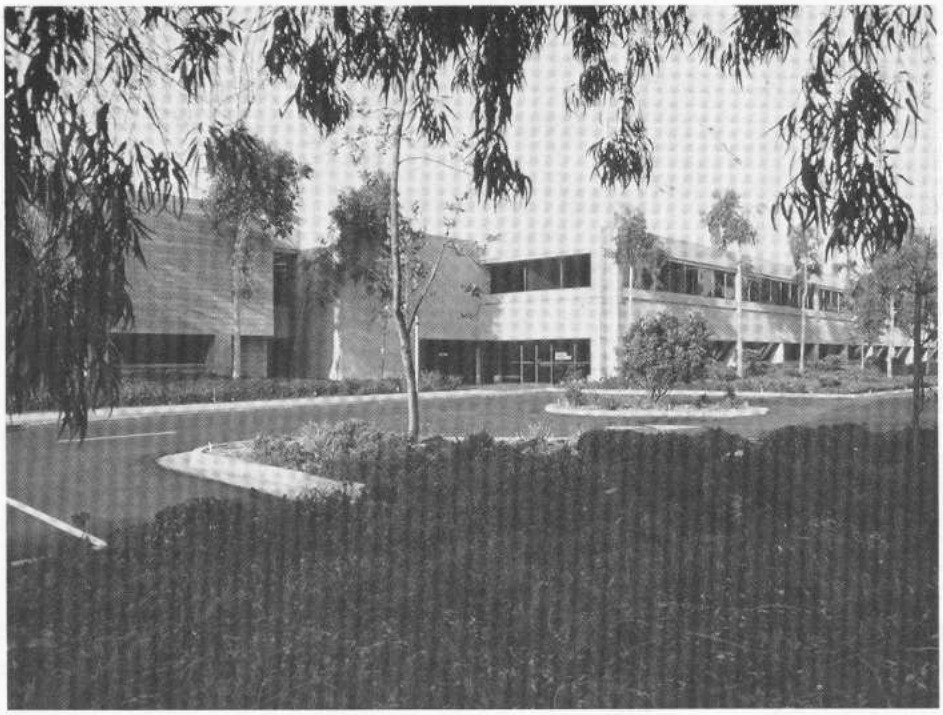
System Model Numbers	Laser Head Model Numbers	Maximum Power Output
3021H	3221H-C	5.0 mW
3021H-P	3221H-PC	5.0 mW
3022H	3222H-C	5.0 mW
3022H-P	3222H-PC	5.0 mW
3023H	3223H-C	6.5 mW
3023H-P	3223H-PC	6.5 mW
3024H	3224H-C	10.0 mW
3024H-P	3224H-PC	10.0 mW
3025H	3225H-C	10.0 mW
3025H-P	3225H-PC	10.0 mW
3027H	3227H-C	15.0 mW
3027H-P	3227H-PC	15.0 mW
3035H	3235H-C	30.0 mW
3035H-P	3235H-PC	30.0 mW
3301H		5.0 mW
3301H-P		5.0 mW
3302H		5.0 mW
3302H-P		5.0 mW
3304H		10.0 mW
3304H-P		10.0 mW
3305H		10.0 mW
3305H-P		10.0 mW
3306H		10.0 mW
3306H-P		10.0 mW

Hughes lasers are designed to meet or exceed applicable U.S. Government safety regulations. The helium-neon lasers in this review are low-power lasers which emit only visible light. As with any other bright source of optical energy — such as the sun or an arc lamp — common sense applies. One should not stare directly into the beam or into its reflections from shiny surfaces.

NCDRH Regulations

All laser products manufactured after August 2, 1976, and sold in the United States, must conform to performance standards and safety regulations 21 CFR 1040.10 and 1040.11, established by the National Center for Devices and Radiological Health (NCDRH) of the U.S. Food and Drug Administration. These performance standards classify laser products on the basis of a combination of emission level, emission duration, and wavelength of accessible radiation emitted during operation. The standard establishes four classes with required safety performance features and identifying warning labels stating maximum output power.

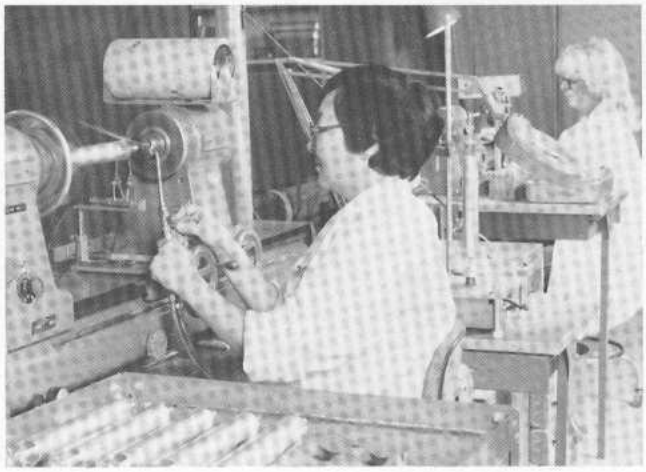
The standard laser products offered in this catalog are within Class II and Class IIIb of the performance standards. All are appropriately labeled as listed above. The emitted radiation is at a wavelength of 632.8 nm for the helium-neon lasers. No X-ray or other harmful radiation is emitted.

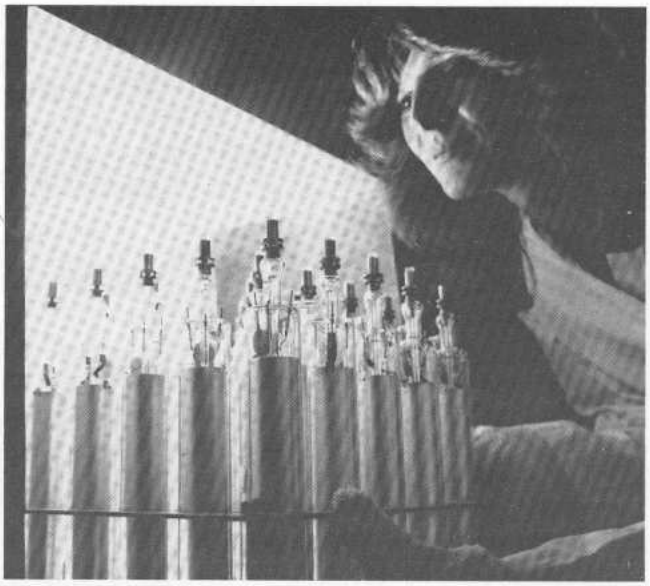


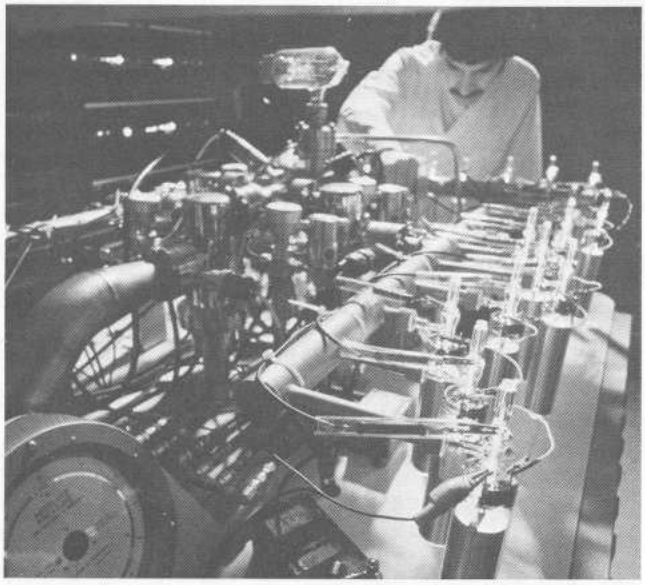
HUGHES Industrial Products Division

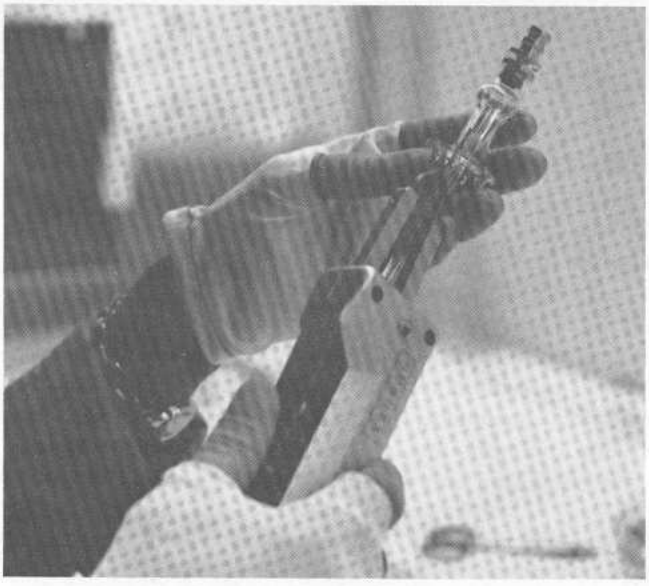
Hughes lasers are developed and manufactured at the Hughes Industrial Products Division in Carlsbad, California. The division occupies two modern facilities encompassing some 350,000 square feet of which approximately 30,000 square feet is environmentally controlled for precision processing and assembly. In addition to lasers, commercial electronic products include vacuum tubes, automatic test equipment, commercial infrared imaging equipment, digital image processing systems, silicon materials and devices, and precision microelectronic bonding and welding systems.

The Hughes Carlsbad facilities are completely staffed and equipped for the design, development and volume production of helium-neon laser systems, subassemblies, and equipment. To meet requirements for high quality, high performance lasers at competitive prices, innovative techniques for volume production with ongoing product improvement are constantly being explored. Hughes Industrial Products Division represents a totally integrated source for industry's most demanding laser requirements.









OEM Laser Development

Hughes designs, fabricates, tests and delivers helium-neon laser equipment that meets the most stringent OEM performance requirements and operating parameters. In addition, Hughes provides assistance to manufacturers in integrating lasers into their products and in meeting NCDRH requirements. Inquiries are invited.

Projected Applications

Hughes is constantly seeking new ways to provide practical commercial utilization of laser technology. For additional information regarding Hughes helium-neon laser systems and equipment and how they may be adapted to your projected applications, you are invited to contact Hughes Industrial Products Division or one of the distributors listed on the back cover.

HUGHES

HUGHES AIRCRAFT COMPANY

INDUSTRIAL PRODUCTS DIVISION
CARLSBAD, CALIFORNIA

For further information about Hughes Laser Products, please contact our representative nearest you.

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